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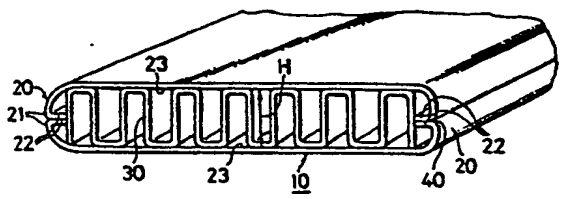
## (54) Flat tube for heat exchanger with inner fin inserted therein.

(57) Aluminum flat tube for heat exchanger with an inner fin inserted therein, comprising a pair of aluminum plate members (20) with both side portions bent like a hook in the same direction to form bends (21), both nose portions formed flat, both the flat portions (22) made opposite on the same horizontal line, and with a brazing material clad at least on the outer surface, an inner fin (30) inserted when the pair of aluminum plate members (20) are put together to a flat tube (10), wherein said pair of aluminum plate members (20) are put together to have the inner fin (30) inserted therein, and then brazed with the flat portions of the bends (21) joined therefor.

FIG.1

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# FLAT TUBE FOR HEAT EXCHANGER WITH INNER FIN INSERTED THEREIN

The present invention relates to an improvement of an aluminum flat tube for heat exchanger with an inner fin inserted therein.

Tubes disclosed in Japanese Patent Laid-Open-Application No. 67529/1986 and others are known hitherto as coming in this kind of flat tube for heat exchanger.

A description will be given thereof with reference to Fig. 12 to Fig. 14 of the enclosed drawings. A reference numeral 1 denotes an aluminum flat tube for heat exchanger, which is obtained through extrusion. In the flat tube 1, as shown in Fig. 6, wall surfaces 2, 3 coming in contact with a heat exchanger fin joined when a heat exchanger core is formed overhang mutually outward for easy insertion of an inner fin 4 as shown in Fig. 13. Then, the inner fin 4 is formed of a corrugated plate of pulse waveform.

The flat tube 1 and the inner fin 4 are unified, for example, as follows, thus forming a flat tube for heat exchanger. First, as shown in Fig. 13, the inner fin 4 is inserted in a space zone formed by both the wall surfaces 2, 3. Then, both the wall surfaces 2, 3 are pressurized to tighten a flat portion 5 in the horizontal direction of the inner fin 4 and insides of both the wall surfaces 2, 3, as shown in Fig. 14.

However, since the inner fin 4 is inserted in the flat tube 1, the flat tube for heat exchanger cannot be assembled so efficiently. Now, therefore, both the wall surfaces 2, 3 must be overhung outward, as shown in Fig. 12, for enhancing efficiency of inserting the inner fin 4, however, such flat tube 1 is not ready for piling in parallel at the time of assembly, which is not preferable for management.

Then, both the wall surfaces 2, 3 of the flat tube 1 are pressurized for inserting the inner fin 4 in the flat tube 1, however, if tightening efficiency of both the two is to be enhanced in this case, then the inner fin 4 is capable of being collapsed. If the inner fin 4 is collapsed, a flow resistance is increased, which is also not preferable. Accordingly, if the flat tube 1 is not pressurized thoroughly to prevent the inner fin 4 from being collapsed, both the wall surfaces 2, 3 are left overhanging outward, and cannot be piled up consequently at the time of core mounting in a post-process, which may deteriorate assembling efficiency. Further, such shape is not to ensure precision of fitting a seat plate in a hole, which is capable of causing a defective brazing.

The invention has for its object to solve the aforementioned problems inherent in the prior art, and to provide a flat tube for heat exchanger with inner fin inserted therein, wherefore an assembling efficiency is enhanced, and a predetermined shape is ensured, so that an inner fin can be inserted easily and securely in a flat tube, and a brazing of the flat tube to a seat plate can be carried out securely.

This object is solved in accordance with the teaching of claim 1. A further advantageous embodiment of the invention is stated in claim 2.

In the invention, the flat tube will be formed tentatively by setting the inner fin on one aluminum plate member and then covering with another aluminum plate member to a unified body. In this case, since flat portions provided on the bends of both aluminum plate members come in face contact with each other, both the two can securely be joined, and a space desirable for inserting the inner fin therein can be secured. Consequently, the inner fin will never be collapsed when both aluminum plate members are joined, and a tightening efficiency of both aluminum plate members and the inner fin can be enhanced.

In the invention, the flat tube is assembled tentatively by disposing ends of the inner fin on flat portions of the butt portions. In this case, since the flat portions of the butt portions hold ends of the inner fin therebetween, the inner fin will never be contracted. Further, the inner fin projects outward from curved portions of the butt portions, therefore the flat tube can be brazed securely to the seat plate.

Preferred embodiments of the invention will now be described with reference to the accompanying drawings, in which

Fig. 1 is a perspective view representing one embodiment of a flat tube for heat exchanger with inner fin inserted therein which relates to the invention;

Fig. 2 is a perspective view showing a state before it is assembled;

Fig. 3 is a front view showing a heat exchanger core using the flat tube for heat exchanger with inner fin inserted therein which relates to the invention;

Fig. 4 is an enlarged view of a main part thereof;

Fig. 5 is an enlarged view showing the state wherein a tube through hole of the seat plate and the flat tube are brazed;

Fig. 6 is a perspective view showing a flat tube for heat exchanger with inner fin inserted therein which is given in one embodiment of the invention;

Fig. 7 is an enlarged side view showing curved portions and the periphery of Fig. 6;

Fig. 8 is a top view showing the state in which the flat tube for heat exchanger with inner fin inserted therein of Fig. 6 is inserted in a seat plate;

Fig. 9 is a side view of Fig. 8;

Fig. 10 is an explanatory drawing showing the curved portions and the periphery in Fig. 8 in enlargement;

Fig. 11 is a perspective view representing another embodiment of the invention;

Fig. 12 to Fig. 14 are explanatory drawings showing a prior art flat tube for heat exchanger with inner fin inserted therein.

Fig. 1 is a perspective view of an aluminum flat tube for heat exchanger relating to the invention, and Fig. 2 is a perspective view showing its assembling state.

A reference numeral 10 denotes an aluminum flat tube for heat exchanger relating to the invention, which comprises brazing integrally through normal process a pair of aluminum plate members 20 with a brazing material clad on inner and outer surfaces and an inner fin 30 inserted when the pair of aluminum plate members 20 are put together to form the flat tube 10.

The pair of aluminum plate members 20 have both side portions bent like a hook in the same direction to form bends 21, both nose portions formed flat, and both flat portions 22 made opposite on the same horizontal line. Then, the aluminum plate members 20 have an inside height H to be formed when put together set to be equivalent to or somewhat smaller than a height h of the inner fin 30.

The inner fin 30 is then bent to a pulse waveform or the like.

The pair of aluminum plate members 20 and the inner fin 30 thus constructed are joined, for example, as follows and then brazed to the flat tube 10.

First, as shown in Fig. 2, one of the aluminum plate members 20 has the inner fin 30 set thereon and then covered with the other aluminum plate member 20 to a unified body.

Next, the flat tube assembled tentatively as above is brazed in a furnace according to a normal process, thus obtaining the flat tube 10 shown in Fig. 1.

In the aforementioned process, the inner fin 30 is set on one of the aluminum plate members 20, which is then covered with the other aluminum plate member 20 from above to join, then since the height H of a space zone of both the two is set to be equivalent to or somewhat smaller than the height h of the inner fin 30 when the bends 21 of both the aluminum plate members 20 come in contact with each other, a force influential to cause a deformation on the inner fin 30 when both the aluminum plate members 20 are assembled will not be applied. Further, since the flat portions 22 formed on the bends 21 of both the aluminum plate members 20 come in face contact with each other, these may function as a stopper to hold an interval between the two at a predetermined value when both the aluminum plate members 20 are assembled.

At the time of the aforementioned brazing, the flat portions 22 provided on the bends 21 of both the aluminum plate members 20 come in face contact with each other, therefore brazing at the portions can securely be carried out. Further, since inside wall surfaces 23 of both the aluminum plate members 20 and flat portions 31 of the inner fin 30 are put into face contact, brazing at the portions can be carried out also securely.

As described above, the aluminum flat tube 10 for heat exchanger is formed by setting the inner fin 30 in one of the aluminum plate members 20, then putting the remaining aluminum plate member 20 thereon, assembling next tentatively with a desired jig to brazing, thus avoiding unnecessary measures prevailing hitherto as pressurizing tube material when the inner fin is inserted, preventing the inner fin from being collapsed when pressurized and so forth.

The aluminum flat tube 10 for heat exchanger manufactured according to the above-described embodiment is fitted on seat plates 51 shown, for example, in Fig. 3 to Fig. 5 to form a heat exchanger core 50. In this case, the seat plate 51 is provided with a burring hole 52 according to an outline of the aluminum flat tube 10 for heat exchanger.

Further, in the invention, since both the aluminum plate members 20 forming the flat tube 10 are bent like a hook, that is, a projection discharged inwardly when both the two are joined is formed, the projection functions as an inner fin. In the invention, accordingly, another stirring effect from that by the inner fin 30 is obtained, a contact efficiency of the flat tube 10 with a coolant can be enhanced in the flat tube 10, thus improving a radiating performance.

Then, in the embodiment described above, a material with a brazing material clad on inner and outer surfaces of the tube is employed, however, that of having a brazing material clad on the outer surface and another brazing material clad on both surfaces of the inner fin may be employed otherwise. Further, the description has referred to the case where the tube alone is brazed in a furnace, however, an assembly of the tube and the fin which is fitted on the seat plates may be brazed in a furnace otherwise. Further, the inner fin may be shaped differently from that of the embodiment. Then, a side-flow type heat exchanger has been taken up for description, however, the invention is

not necessarily limited thereto, and hence a downflow type heat exchanger may be exemplified therefor. Further, the invention can be applied not only to an intercooler for vehicle but also to heat exchangers such as radiator, heater core, evaporator, condenser and the like. Still further, the fin inserted on outside of the flat tube 10 for heat exchanger relating to the invention may be a plate fin other than the corrugated fin so specified in the above-described embodiment.

As described above, in a tube for heat exchanger comprising an aluminum flat tube with a brazing material clad on the outer surface, an inner fin inserted in the aluminim flat tube, the invention relates to an aluminum flat tube for heat exchanger comprising a pair of aluminum plate members with both side portions bent like a hook in the same direction to form bends, both nose portions formed flat, both the flat portions made opposite on the same horizontal line, and with a brazing material clad at least on the outer surface, an inner fin inserted when the pair of aluminum plate members are put together to a flat tube, wherein the pair of aluminum plate members are put together to have the inner fin inserted therein, and then brazed with the flat portions of the bends joined therefor, and hence it can be formed so that both wall surfaces of the flat portions other than both ends will be almost parallel, these can thus be piled up in parallel at the time of assembling work, therefore not only storage and management will be facilitated, but also a working efficiency at the time of assembling can sharply be enhanced. Then, a flat tube body side need not be kept overhanging outward beforehand for inserting the inner fin, therefore a forming process can be simplified. Further, one of the aluminum plate members has the inner fin set therin beforehand and then covered with the remaining aluminum plate member, therefore the inner fin can be set easily in the flat tube without being collapsed. Furthermore, since both aluminum plate members and inner fin are kept coming in face contact with each other, a thermal conductivity is very good, and a radiating performance of a coolant circulating in the flat tube is enhanced. Then, an inward swelling portion formed by bends of both the aluminum plate members functions as an inner fin, therefore a radiating performance can further be enhanced. Meanwhile, a roll forming is ready from rolled materials and a plate thickness tolerance can be minimized as compared with a hot extruded material, therefore it can be thinned in an average thickness to a merit on the premise that a strength is ensured on the minimum thickness. Further, sacrificial preserva tives (7072 material and the like) can be clad on the inside for corrosion resistance, which is advantageous, too.

Fig. 6 and Fig. 7 represent a flat tube for heat exchanger with inner fin inserted therein which is given in one embodiment of the invention, wherein a reference numeral 61 denotes an aluminum flat tube, and an inner fin 63 is inserted in the flat tube 61.

The flat tube 61 has a pair of tube semimembers 65, 66 put together therefor in construction.

Each of the tube semimembers 65, 66 has curved portions 67 curved inward formed on both sides thereof, and flat portions 69 running inward are formed on ends of the curved portions 67. Butt portions are formed by the curved portions 67 and the flat portions 69. Then, a brazing material 71 is clad, as shown in Fig. 7, on outer surfaces of the tube semimembers 65, 66.

On the other hand, the inner fin 63 consists of a corrugated plate, and a held portion 73 wrought flat is formed on both sides thereof. A width of the held portion 73 is made somewhat longer than the width of the flat portions 69 of the tube semimembers 65, 66.

In the flat tube for heat exchanger with inner fin inserted therein which is constructed as above, with the flat portion 69 of the lower side tube semimember 66 facing upward, the held portion 73 of the inner fin 63 is placed on the flat portion 69, and then with the flat portion 69 facing downward, the upper side tube semimember 65 is put thereon, that is to say, the pair of tube semimembers 65, 66 are put together through the held portion 73 of the inner fin 63, thereby assembling the flat tube 61 tentatively. Then, the held portion 73 of the inner fin 63 is left protruding somewhat outward, in this case, from the curved portions 67 of the tube semi members 65, 66.

Then, the flat tube 61 assembled tentatively as above is inserted in a burring hole 77 formed on a seat plate 75, as shown in Fig. 8 and Fig. 9, straight or after assembled regularly through brazing in a furnace according to normal process, brazed in a furnace together with a corrugated fin 79, and thus a core part is assembled.

Furthermore, in the flat tube for heat exchanger with inner fin inserted therein which is constructed as above, since the flat portions 69 provided on the curved portions 67 of both the tube semimembers 65, 66 hold the held portion 73 of the inner fin 63 therebetween, the inner fin 63 will never be shrunk inward. Thus, the inner fin 63 can be inserted securely in the flat tube 61.

Further, in the flat tube for heat exchanger with inner fin inserted therein which is constructed as described above, since ends of the held portion 73 of the inner fin 63 are made to protrude outward, as shown in Fig.10, from the flat portions 69 of both the tube semimembers 65, 66, the ends of the held portion 73 of the inner fin 63 come to position

in a space between the curved portions 67, 67 of the pair of tube semimembers 65, 66 from inserting the flat tube 61 in the burring hole 77 formed on the seat plate 75, and thus a space zone 81 formed between the seat plate 75 and the flat tube 61 decreases in area.

As a result, the flat tube 61 can be brazed to the seat plate 75 securely.

Fig. 11 represents another embodiment of the invention, wherein a flat tube 83 is constructed by bending a sheet of plate 85, and a butt portion consisting of the curved portions 67 and the flat portions 69 is formed on both ends of the plate 85. Accordingly, the butt portion is formed only on one side of the flat tube 83.

An effect almost similar to the aforementioned embodiment is obtainable also in this embodiment.

As described above, in the invention, the flat tube is constructed by putting together a pair of tube semimembers or by bending a plate, the butt portions are formed of curved portions curved inward and flat portions running from ends of the curved portions, the inner fin is inserted between the flat portions of the butt portions at both sides or one side thereof, further the inner fin is projected outward from the pair of flat portions opposite each other at both sides or one side thereof, therefore the inner fin can be inserted easily and securely in the flat tube, and the flat tube can be brazed to the seat plate securely, too.

## Claims

1. In a tube for heat exchanger comprising an aluminum flat tube (10, 61, 83) with a brazing material (71) clad on the outer surface, an inner fin (30, 63) inserted in the aluminum flat tube, **characterized** by a pair of aluminum plate members (20) with both side portions bent like a hook in the same direction to form bends (21), both nose portions formed flat, both the flat portions (22, 69) made opposite on the same horizontal line, and with a brazing material (71) clad at least on the outer surface, an inner fin (30, 63) inserted when the pair of aluminum plate members (20) are put together to a flat tube (10), wherein said pair of aluminum plate members (20) are put together to have the inner fin (30, 63) inserted therein, and then brazed with the flat portions of the bends (21) joined therefor.

2. In a flat tube (61, 83) for heat exchanger with inner fin (63) inserted therein, **characterized** in that said flat tube (61) is formed by putting together a pair of tube semimembers (65, 66) or by bending a plate member (20), the butt portions are formed of curved portions (67) curved inward and flat portions (69) coming after ends of the curved portions (67), said inner fin (63) is inserted between the flat portions (69) of said butt portions at both sides or one side thereof, further the inner fin (63) is projected outward from said opposite pair of flat portions (69) at both sides or one side thereof.

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FIG.1

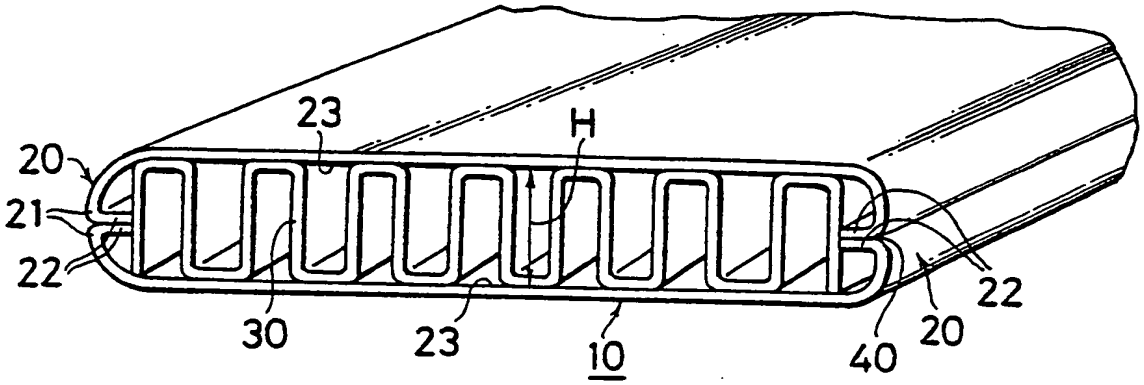


FIG.2

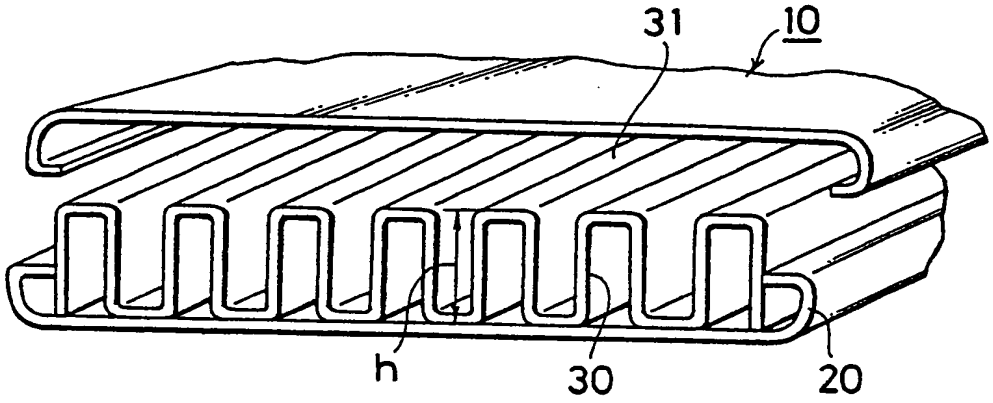


FIG.3

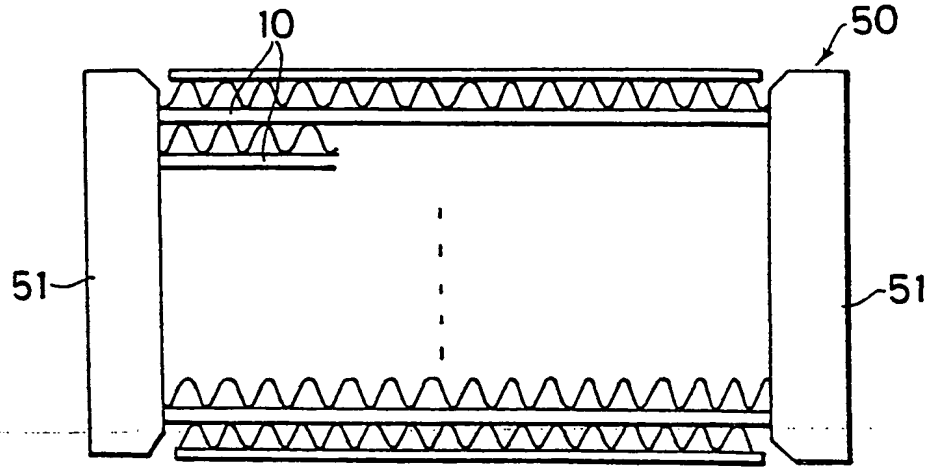

FIG.4

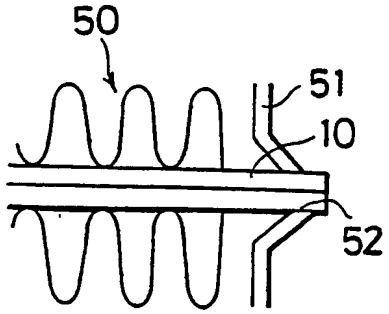


FIG.5

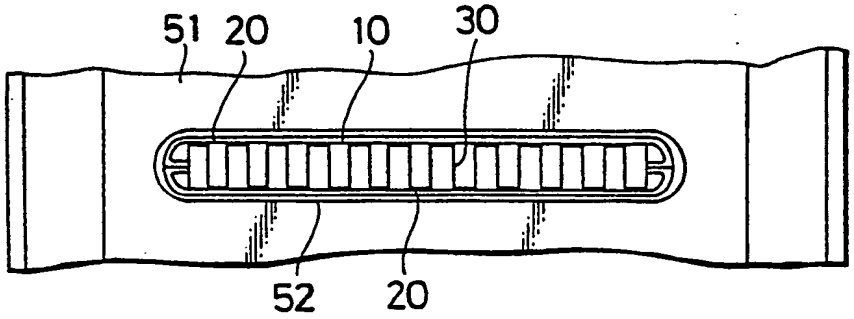


FIG.6

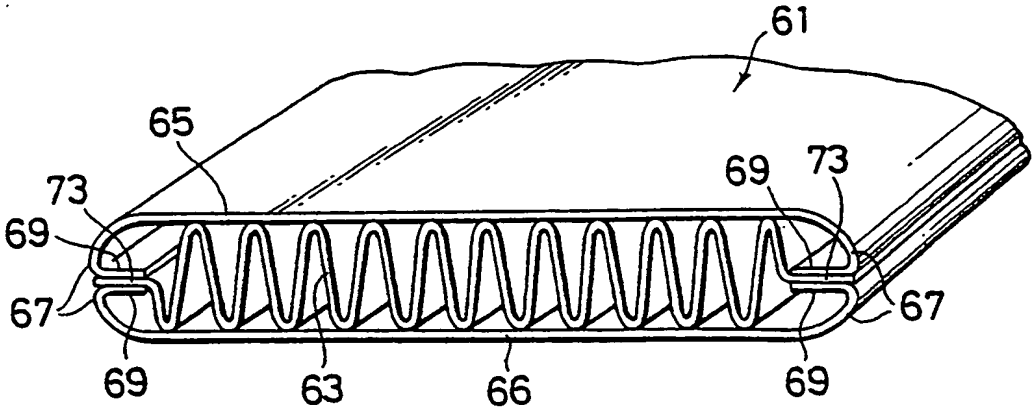

FIG.7



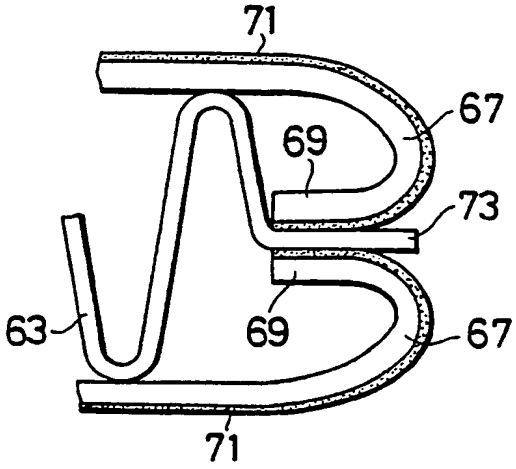


FIG.8

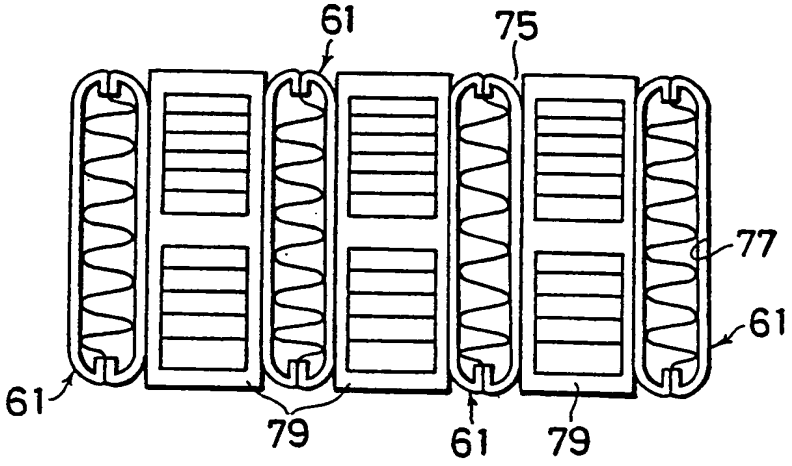


FIG.9

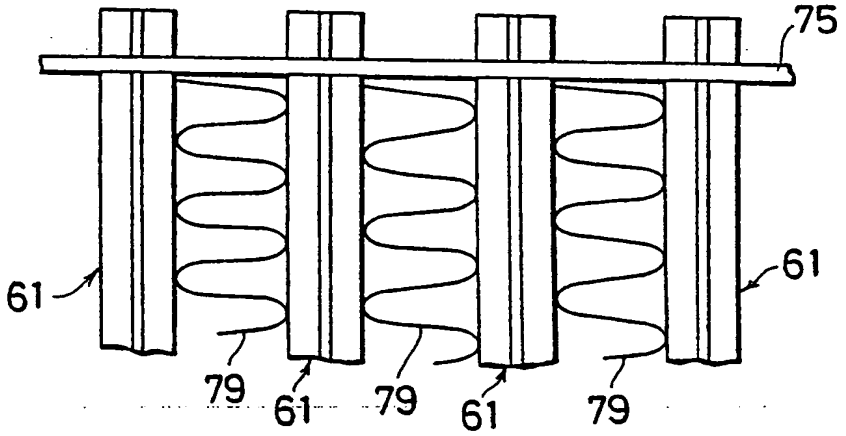

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FIG.10

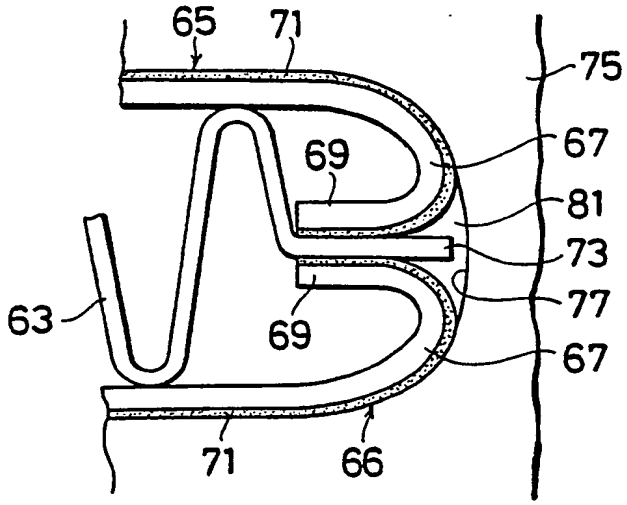



FIG.11

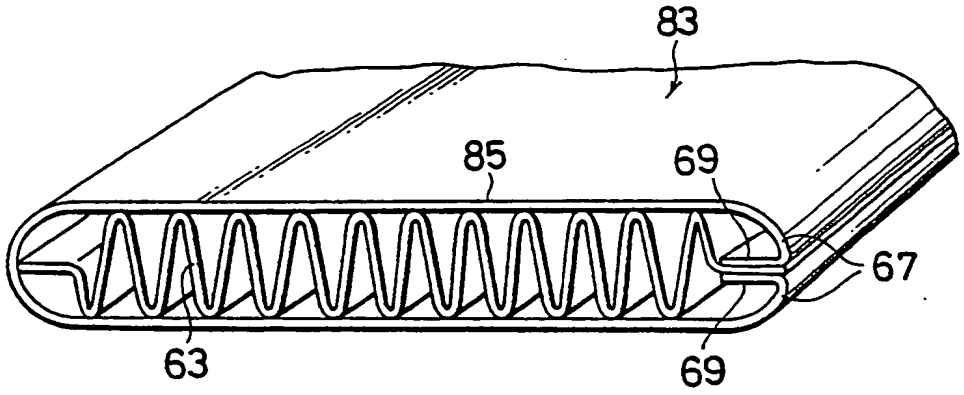


FIG.12

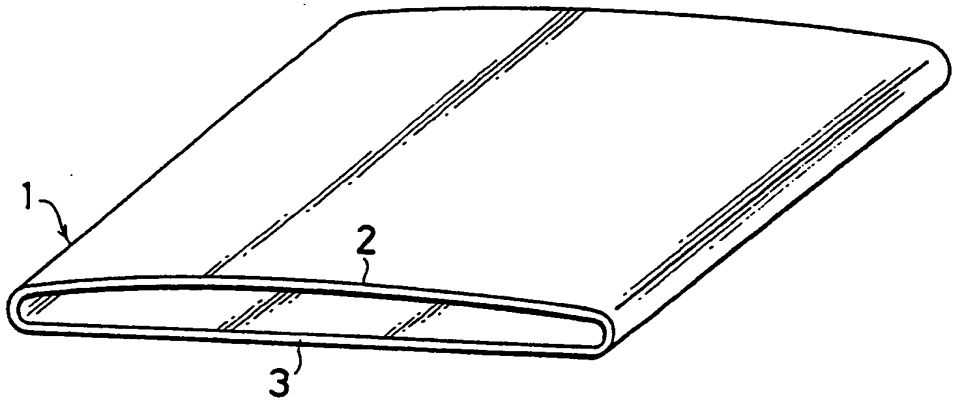



FIG.13

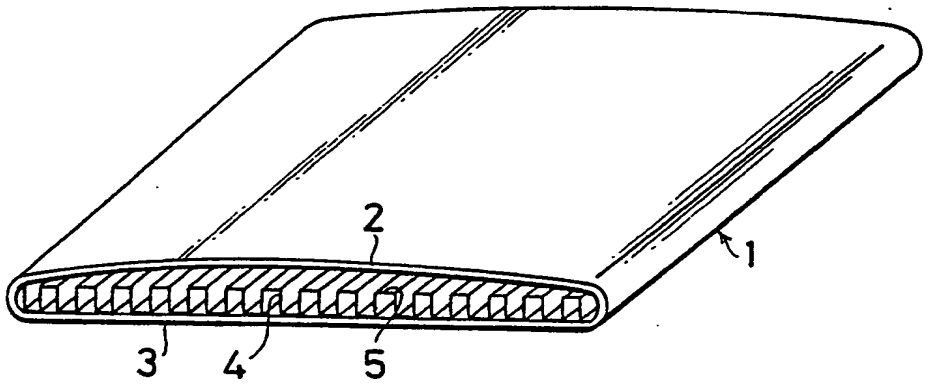
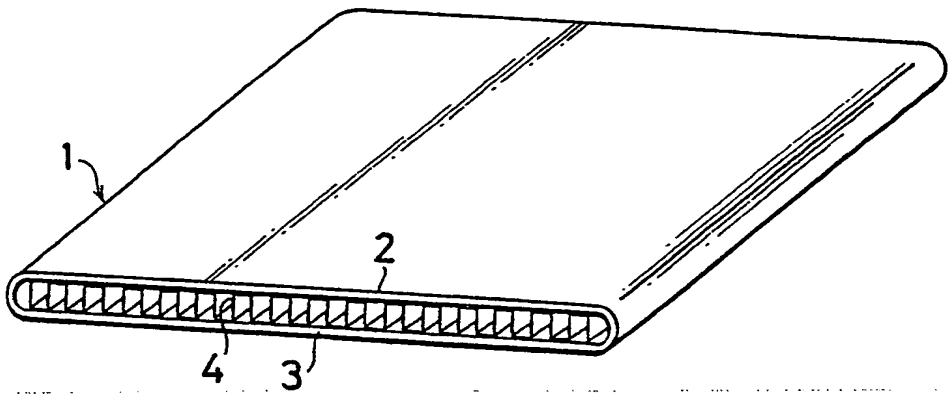



FIG.14



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# EUROPEAN SEARCH REPORT

Application Number

EP 88 10 4268

## DOCUMENTS CONSIDERED TO BE RELEVANT

| Category | Citation of document with indication, where appropriate, of relevant passages | Relevant to claim | CLASSIFICATION OF THE APPLICATION (Int. Cl.4) |
|---|---|---|---|
| X | US-A-3 212 572 (OTTO)<br>* Column 1, line 67 - column 2, line 72; column 3, lines 39-41; figures 2-4 * | 1 | F 28 F 3/02<br>F 28 D 1/03 |
| Y | | 2 | |
| Y | PATENT ABSTRACTS OF JAPAN, vol. 10, no. 118 (M-475)[2175], 2nd May 1986; & JP-A-60 247 426 (SHIYOUWA ARUMINIUMU K.K.) 07-12-1985<br>* Abstract * | 2 | |
| X | US-A-2 959 401 (BURTON)<br>* Column 2, line 13 - column 3, line 41; figures 2-7 * | 1 | |
| A | | 2 | |
| Y | US-A-2 912 749 (BAUERNFEIND et al.)<br>* Column 3, line 9 - column 4, line 44; figures 1-7 * | 1 | |
| Y | GB-A- 780 045 (MORRIS MOTORS LTD)<br>* page 1, line 93 - page 2, line 28; figures 1-3 * | 1 | TECHNICAL FIELDS SEARCHED (Int. Cl.4)<br>F 28 D<br>F 28 F<br>B 21 C<br>B 21 D |
| A | PATENT ABSTRACTS OF JAPAN, vol. 9, no. 268 (M-424)[1991], 25th October 1985; & JP-A-60 114 698 (NIPPON DENSO K.K.) 21-06-1985 | 1,2 | |
| A | GB-A-2 133 525 (NIPPONDENSO CO., LTD)<br>* Page 1, lines 79-84; page 2, lines 57-64; figures 8,9 * | 1,2 | |

The present search report has been drawn up for all claims

| Place of search | Date of completion of the search | Examiner |
|---|---|---|
| THE HAGUE | 14-06-1988 | BELTZUNG F.C. |

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
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